



IN THE MATTER OF  
United States Patent Application No. 09/889537

## DECLARATION

Professor James Lucas declares and says:

1. I am Professor of Electrical Engineering and Electronics at the University of Liverpool in the United Kingdom. I am one of the inventors of the apparatus described in US Patent Application 09/889537 (hereinafter referred to as "the Liverpool University device") and have been very closely involved in all stages of a programme to develop a commercial embodiment of it and to test it. The following facts are all either from my own knowledge or from documents to which I have access.
2. The Liverpool University device functions by emitting radiation (specifically microwaves, in the commercial version of the device which we are developing) into a resonant chamber or cavity. This chamber is defined by a wall which conducts electricity and is, in the prototype device, formed of metal. If the resulting microwave field in the chamber is measured then inferences can be drawn about the nature of the material within it. In this way, when the device is combined with other types of monitoring apparatus, so-called "multi-phase metering" of material flowing through the chamber can be achieved.
3. In the Liverpool University device, the metal wall defining the chamber is electrically insulated from the material within it. Likewise, the antenna used to launch microwaves into the chamber is insulated from the chamber's contents. This electrical isolation is fundamental to the function and performance of the Liverpool University device. It makes it possible to operate the device at very low emitted microwave power while still obtaining accurate measurements. The Liverpool University device requires only about 1 *milliWatt* of emitted microwave power to carry out its function.

4. With such a low power requirement, it is straightforward to provide and detect a variable wavelength of radiation, making possible the measurement for example of resonance peaks as described in our patent application. The low power requirement is also potentially very important in multi-phase metering of hydrocarbon flows which are of course volatile, so that emission of significant heat energy into the flow would give rise to safety concerns.

5. I am aware of US Patent 510163 (Agar). I am also aware that the Agar Corporation sells an "oil/water - liquid-concentration monitor" based upon microwave absorption. Enclosed as Exhibit A is a printout from the Agar Corporation website showing details of the Agar OW-201 monitor and also of the Agar MPFM-400 multiphase flow meter. This type of monitor relies on relatively high microwave power. To my knowledge Agar has previously referred to the use of one kiloWatt of power in this type of monitor. Since then, the distance between the transmitter and the receiver has been reduced and I note that in the attached literature there is reference to the monitor requiring 34 or 24 Watts total input power. Nonetheless, the Agar monitor, both as offered commercially and as described in the Agar patent application, requires orders of magnitude greater microwave power than the Liverpool University device. We have been able to make the power reduction by virtue of the fact that in the Liverpool University device the contents of the resonant chamber are isolated electrically from the chamber wall and from the antenna which serves to emit microwaves.

6. Agar's monitor is also fundamentally different from the Liverpool University device in that it relies on measurement of attenuation of the microwave signal. As explained above, at the low powers required by the Liverpool University device other types of measurement can easily be made such as measurement of resonant frequencies of the chamber, and also the phase relationship between the input and output signals.

I declare further that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further, that the statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Signed by James Lucas  
Professor James Lucas

on 12 MARCH 2004

Witnessed by [Signature]  
Witness signature

Witness Name D. A. AL-SHAMMAH